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| 09/863,224      | 05/24/2001  | Ming-Hsing Tsai      | TS00-563            | 9872             |

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EXAMINER

BEREZNY, NEAL

ART UNIT PAPER NUMBER

2823

DATE MAILED: 01/12/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

# Office Action Summary

Application No.

09/863,224

Applicant(s)

TSAI ET AL.

Examiner

Neal Berezny

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-- The MAILING DATE of this communication appears on the cover sheet with the corresponding address --

## Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

## Status

- 1) ☒ Responsive to communication(s) filed on 08 September 2003.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

## Disposition of Claims

- 4) ☒ Claim(s) 1-33 is/are pending in the application.
- 4a) Of the above claim(s) 31-33 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-22, 25, 26 and 28-30 is/are rejected.
- 7) ☒ Claim(s) 23, 24 and 27 is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

## Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 24 May 2001 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

## Priority under 35 U.S.C. §§ 119 and 120

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).  
a) ☐ All b) ☐ Some \* c) ☐ None of:  
1. ☐ Certified copies of the priority documents have been received.  
2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.  
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).  
\* See the attached detailed Office action for a list of the certified copies not received.
- 13) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application) since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.  
a) ☐ The translation of the foreign language provisional application has been received.
- 14) ☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121 since a specific reference was included in the first sentence of the specification or in an Application Data Sheet. 37 CFR 1.78.

## Attachment(s)

- 1) ☐ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) \_\_\_\_\_
- 4) ☐ Interview Summary (PTO-413) Paper No(s) \_\_\_\_\_
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: \_\_\_\_\_

**DETAILED ACTION**

***Claim Rejections - 35 USC § 103***

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1, 3-5, 7-10, 12-16, 18-20, 22, 25-26, 28, and 30 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhou et al. (6,358,842) in combination with Lou et al. (5,916,823). Zhou teaches a method to solve via poisoning for insulative porous low-k materials, see abstract, comprising the steps of: providing a silicon substrate, col.3, ln.55-57, having a silicon nitride passivation layer with a thickness of 30-1000 Angstroms, col.4, ln.12-15, formed over a first metal layer formed on said substrate; fig.4, el.50, 58, and 54, forming a first insulative layer, with a thickness of 2000-100000 Angstroms, col.4, ln.49-52, over said substrate; el.62, forming a silicon nitride etch-stop layer, col.4, ln.60-63, with a thickness of 30-1000 Angstroms, col.4, ln.65-67, over said first insulative layer; el.66, forming a second insulative layer, with a thickness of 2000 to 100000 Angstroms, col.5, ln.34-37, over said etch-stop layer; el.70, forming a first photoresist layer over said second insulative layer and patterning said photoresist to form a first photoresist mask having a hole pattern; fig.5, el.78, etching said first and second insulative layers, including said etch-stop layer through said hole pattern to form a hole reaching said passivation layer; fig.5, removing said first photoresist mask; forming a low-k protection layer over said substrate, including in said hole opening; fig.6, el.82, forming a second photoresist layer over said substrate, including said hole opening and patterning said second

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photoresist to form a second photoresist mask having a trench pattern; fig.9, etching said second insulative layer through said trench pattern in said second photoresist mask to form a trench in said second insulative layer, thus completing the forming of said dual damascene structure in said substrate; fig.10, removing said second photoresist mask; fig.11, removing said low-k protection layer from over said substrate and from the bottom of said hole opening and thereby exposing underlying said passivation layer while leaving said low-k protection layer on the vertical sides of said hole opening; fig.6, el.82, removing said passivation layer from said bottom of said hole opening, thereby exposing underlying said first metal layer; fig.7, el. 82, 86, forming a barrier layer over said substrate, including in said dual damascene structure; fig.13, el.104, wherein said barrier layer conforms to said low-k protective layer in said hole opening and conforms to said trench in said second insulative layer, col.8, ln.49-64, depositing a second metal, such as copper, over said barrier layer in said dual damascene structure; fig.13, el.106, and performing chemical mechanical polishing (CMP) to complete the forming of said dual damascene structure, col.8, ln.62-63. Further, Zhou teaches forming a low-k protection layer comprises small amounts of SiO<sub>2</sub>, SiN, SiC and SiNC, col.6, ln.18-25, wherein said low-k protection layer has a thickness between about 20 to 1000 Å, col.6, ln.46-50, and wherein said barrier layer comprises Ta, Ti, TaN, TiSiN, TaSiN, WN, col.8, ln.56-58.

3. Zhou appears not to teach forming the low-k protection layer on the second insulative layer, nor where the protection layer prevents outgassing from the first and second insulating layer, because Zhou only teaches small quantities of SiO<sub>2</sub> in the protective layer. Lou teaches forming the low-k protection layer on the second insulative layer, fig.5, el.128, col.3, ln.30-48, where the protection layer is composed of CVD oxide, col.3, ln.30-48, and having a thickness,

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col.3, ln.36-37, sufficient to prevent outgassing from the first and second insulating layer. It would be obvious to one of ordinary skill in the art at the time of the invention to combine Lou with Zhou to modify Zhou with an alternative protective layer material that also reduces outgassing as taught by Lou, col.3, ln.41-43, so as to further reduce via poisoning, Zhou, col.6, ln.32-34.

4. Zhou also teaches that the capping layer, el.74, is optional, col.5, ln.38-40. Therefore, combining Lou with that embodiment of Zhou which lacks the capping layer, a skilled artisan would be motivated to replace the sulfonating process of Zhou with the CVD process of Lou, thus forming the protection layer on the second insulating layer, as claimed.

5. Claims 11 and 29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhou and Lou as applied to claims 1, 3-5, 7-10, 12-16, 18-20, 22, 25-26, 28, and 30 above, and further in view of Lin (6,140,220). Lou fails to teach a barrier layer and Zhou appears not to specify the thickness of the barrier film, nor the etch chemistry used to etch the first and second insulators, the etch stop layer, and the protective layer. Lin teaches forming a barrier layer comprising Ta or TaN, having a thickness of 100-2000 Angstroms, col.4, ln.18-23. It would have been obvious to one of ordinary skill in the art at the time of the invention to combine Lin with Zhou to use a barrier layer of the same material with a thickness used by Lin to prevent via poisoning, thereby reducing contamination of the interconnect structure.

6. Claims 2, 6, 17, and 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Zhou and Lou as applied to claims 1, 3-5, 7-10, 12-16, 18-20, 22, 25-26, 28, and 30 above, and further in view of Eissa et al. (US2002/0127876). Zhou and Lou appear not to specify the k value of the low-k dielectric used in the first and/or the second dielectric. Eissa teaches the use

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of a low-k dielectric in a copper dual damascene interconnect structure having a k value between 2.0 and 3.0, page 1, par. [0010]. It would have been obvious to one of ordinary skill in the art at the time of the invention to select a low-k dielectric having a k-value between 2.0 and 3.0 in an interconnect structure having copper, in order to reduce the parasitic capacitance of the interconnect thereby reducing the RC constant and increasing the speed and performance of the devices.

***Allowable Subject Matter***

7. Claims 23-24, and 27 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims. Applicant claims a specific combination of etchants, specifically, C<sub>2</sub>F<sub>6</sub>, C<sub>4</sub>F<sub>3</sub>, Ar, N<sub>2</sub>, and O<sub>2</sub>, which are used to etch the porous low-k first and second insulative layers. Further, applicant asserts that the claimed particular gas combination is particularly effective in the etching of low-k insulative layers. In conclusion, the examiner has not found any art either singly or in combination that suggests that one of ordinary skill in the art at the time of the invention would have been able to anticipate and/or practice the claimed invention, without undue experimentation.

***Response to Arguments***

8. Applicant's arguments with respect to claims 1-30 have been considered but are moot in view of the new ground(s) of rejection. Examiner would like to point out that the language of claim 13 permits for the following sequence of removing the first resist, forming the second resist, etching the trench, removing the second resist, and forming the low-k protective layer, which is found in the Zhou and Lou combination.

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***Conclusion***

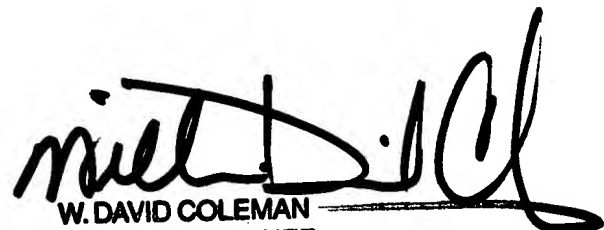
9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Neal Berezny whose telephone number is (703) 305-1481. The examiner can normally be reached on M-F 9:00 - 5:30.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Olik Chaudhuri can be reached on (703) 306-2794. The fax phone number for the organization where this application or proceeding is assigned is (703) 308-7724.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (703) 308-0956.

NB

January 8, 2004

  
W. DAVID COLEMAN  
PRIMARY EXAMINER